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Blincoe et al.

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(54) **LIGHT-EMITTING DIODE (LED) FLOODLIGHT**

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(51) **Int. Cl.**

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F21V 7/00	(2006.01)
F21V 21/00	(2006.01)

(52) **U.S. Cl.**
CPC .. ***F21V 7/00*** (2013.01); ***F21V 21/00*** (2013.01)
USPC **362/294**; 362/249.02; 362/311.02; 362/373

(58) **Field of Classification Search**
USPC 362/249.02–249.06, 294, 311.02, 373, 362/800
See application file for complete search history.

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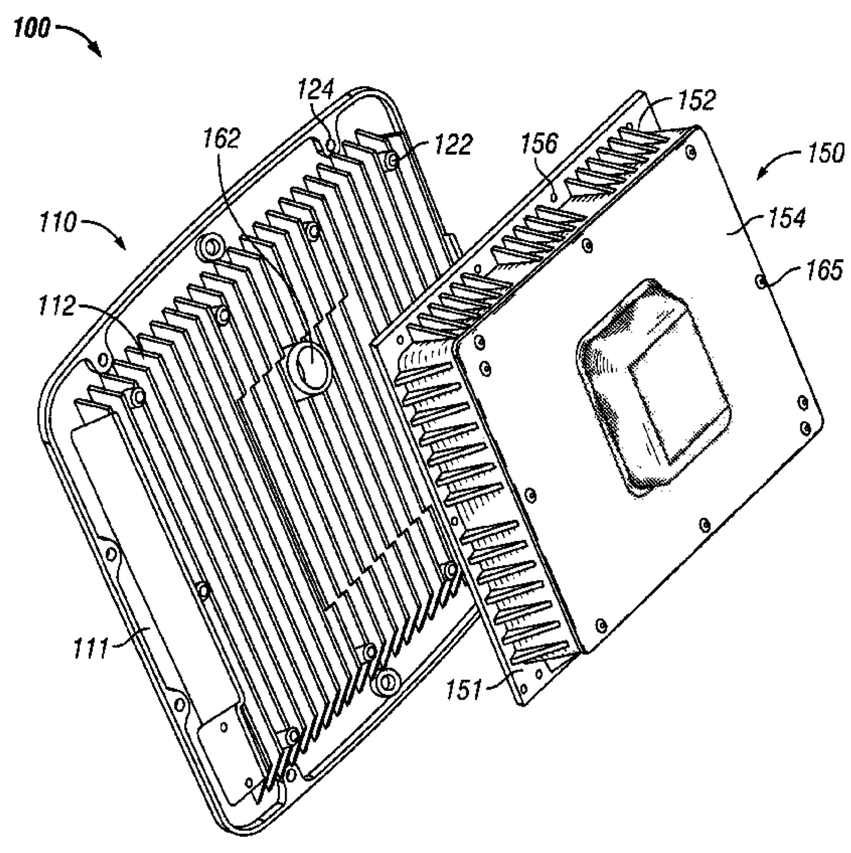
(74) *Attorney, Agent, or Firm* — King & Spalding LLP

(57) **ABSTRACT**

A light emitting diode (LED) floodlight is described herein. The LED floodlight can include a LED housing assembly coupled to a driver assembly. The LED housing can include a number of LEDs mounted on a front side of a LED housing and a number of heat sink protrusions extending from a back side of the LED housing. The driver assembly can include a driver mounted within a driver housing, where the front side of the driver housing couples to the end of the heat sink protrusions that extend from the back side of the LED housing. The LEDs may be coupled to a number of reflectors. The reflectors can include a reflector body having a top portion and a bottom portion. The top portion can form a shape that is an elongated version of the shape formed by the bottom portion.

20 Claims, 12 Drawing Sheets



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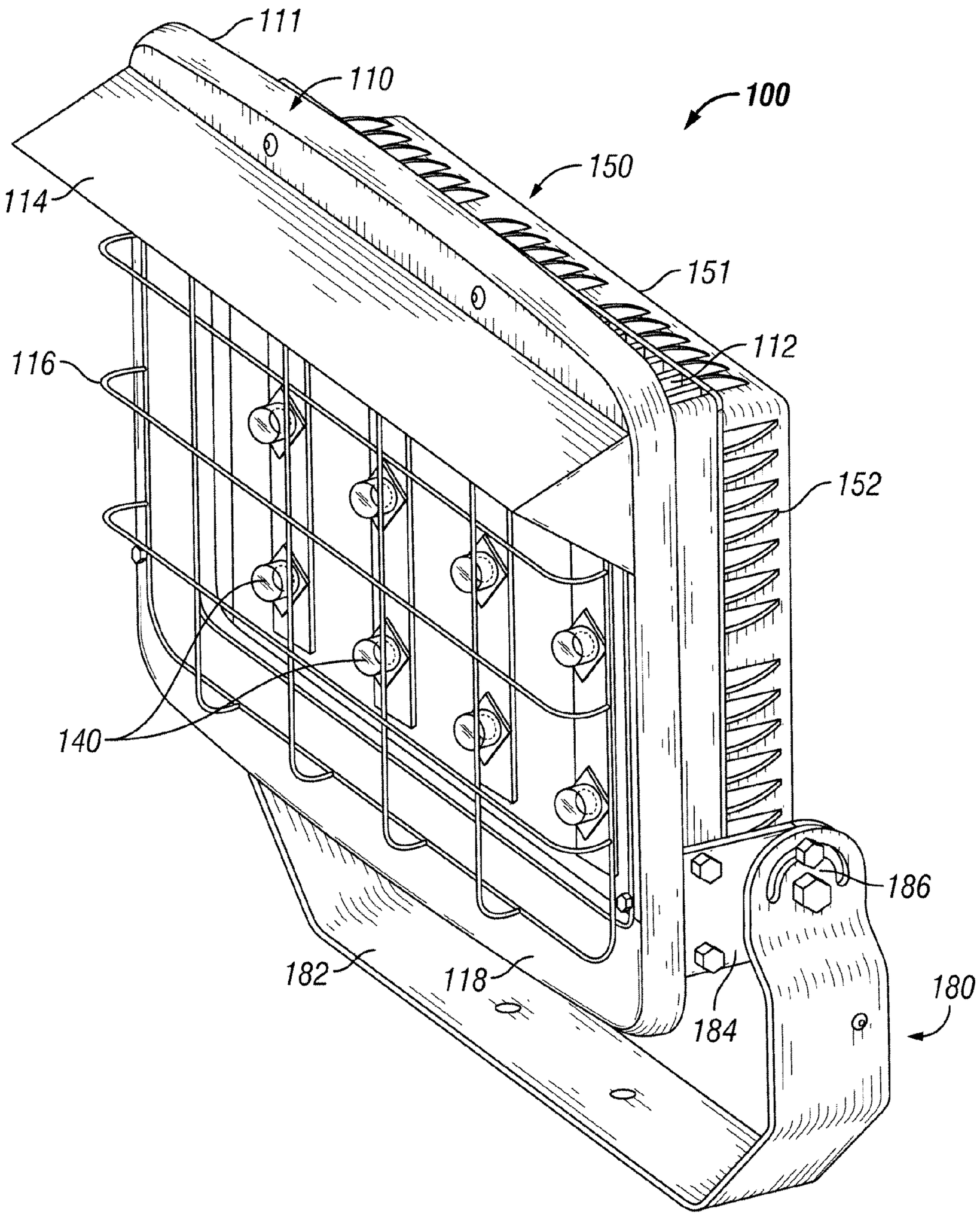

FIG. 1A

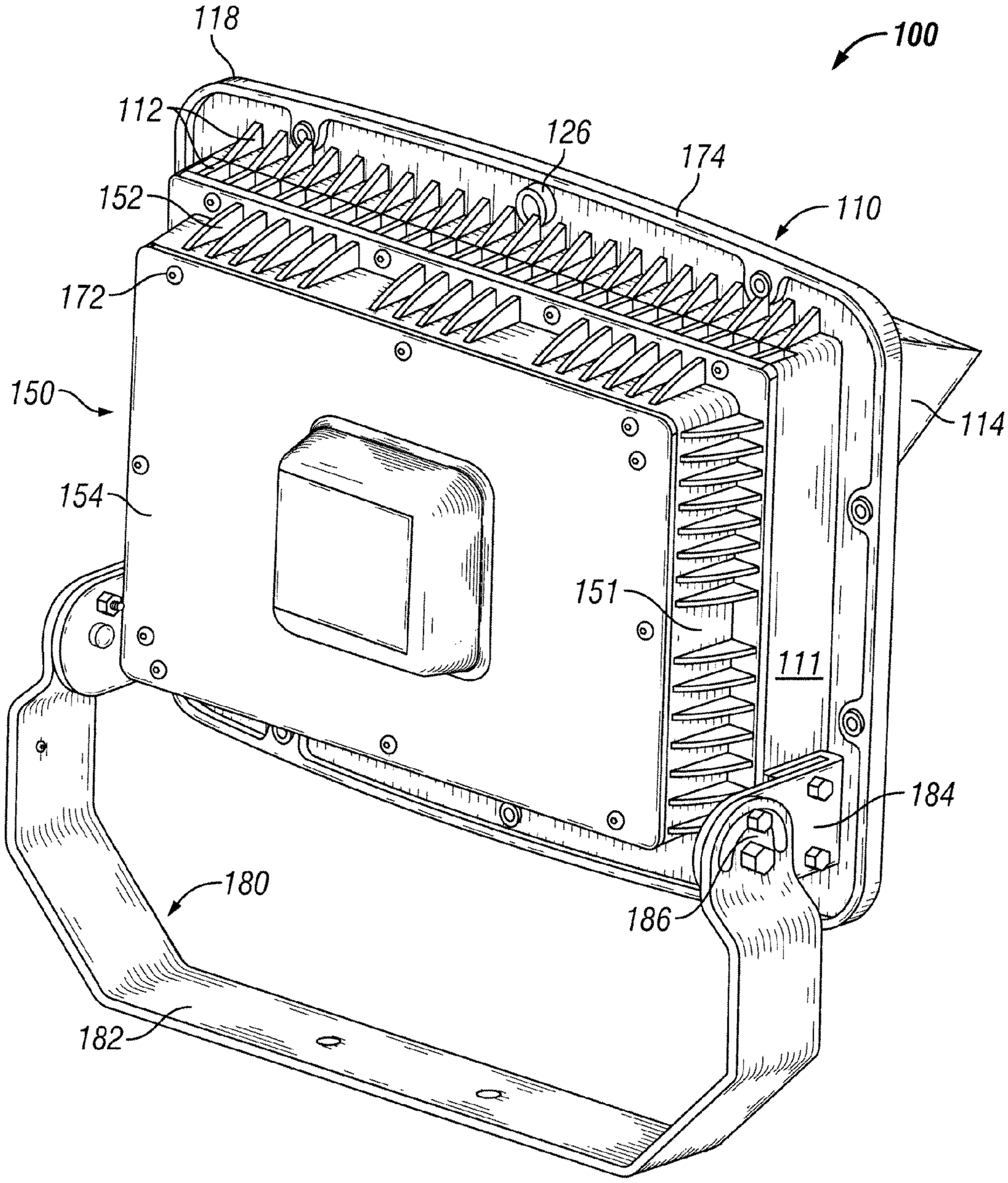
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FIG. 1B

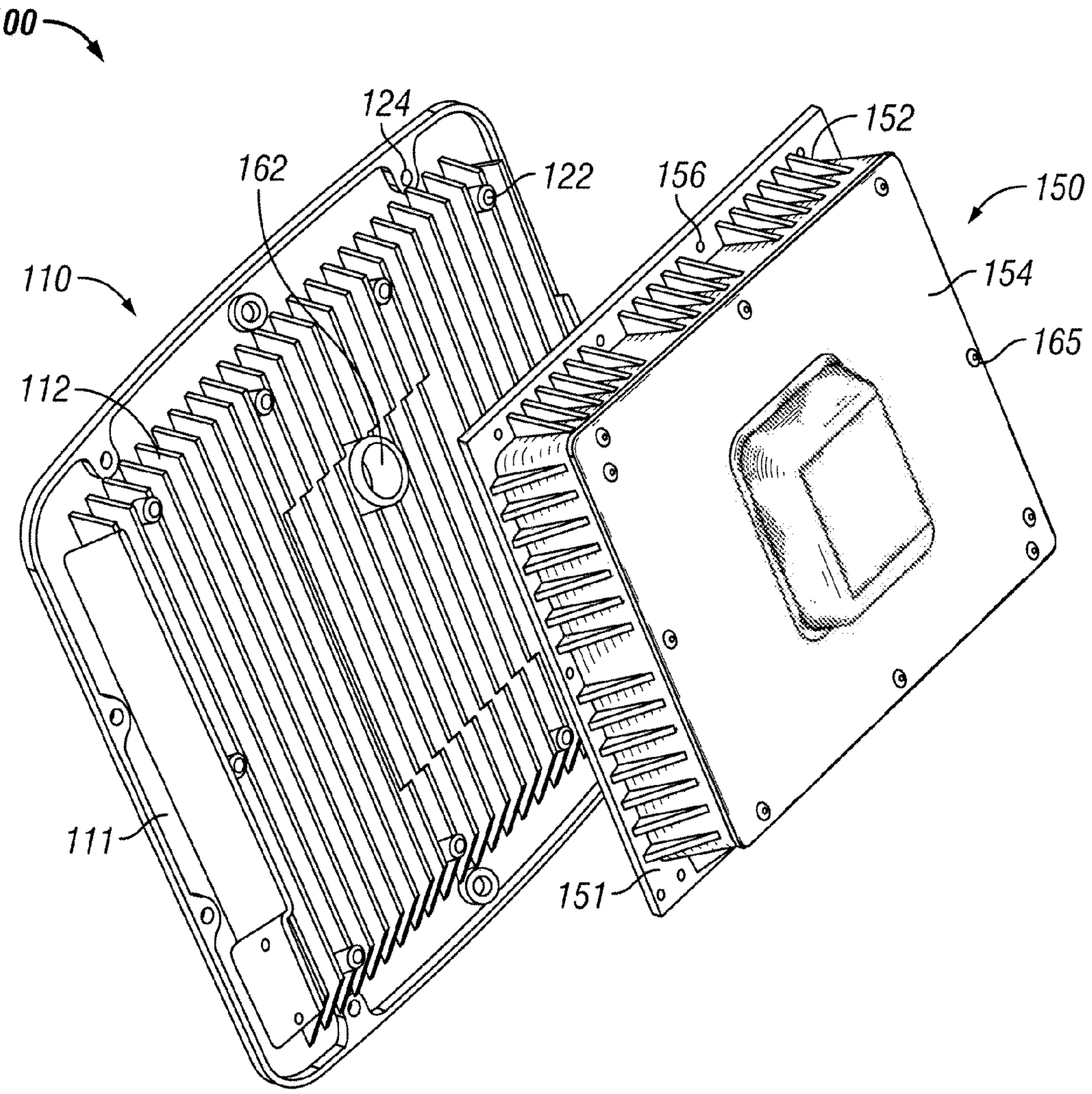

FIG. 1C

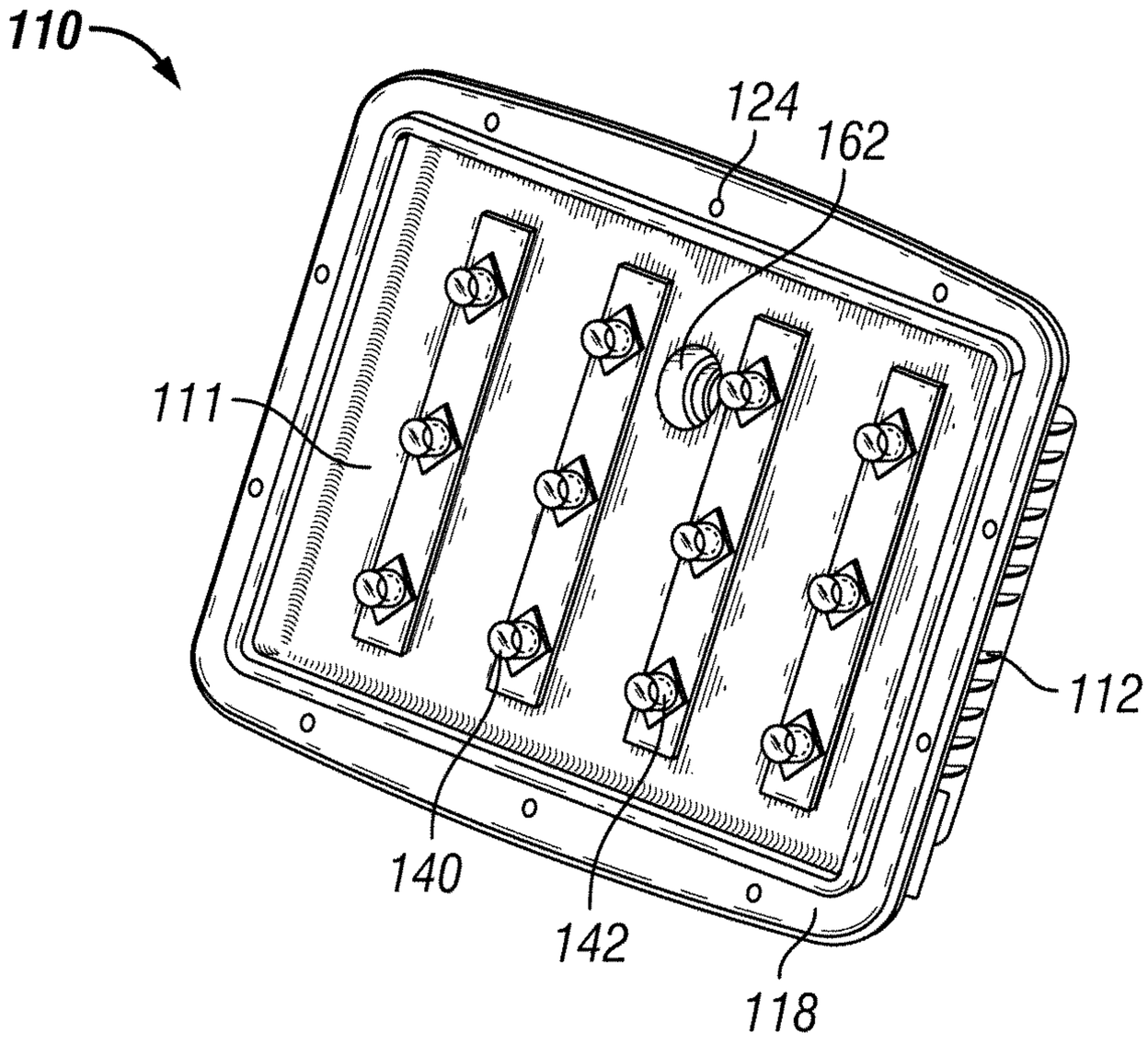

FIG. 2A

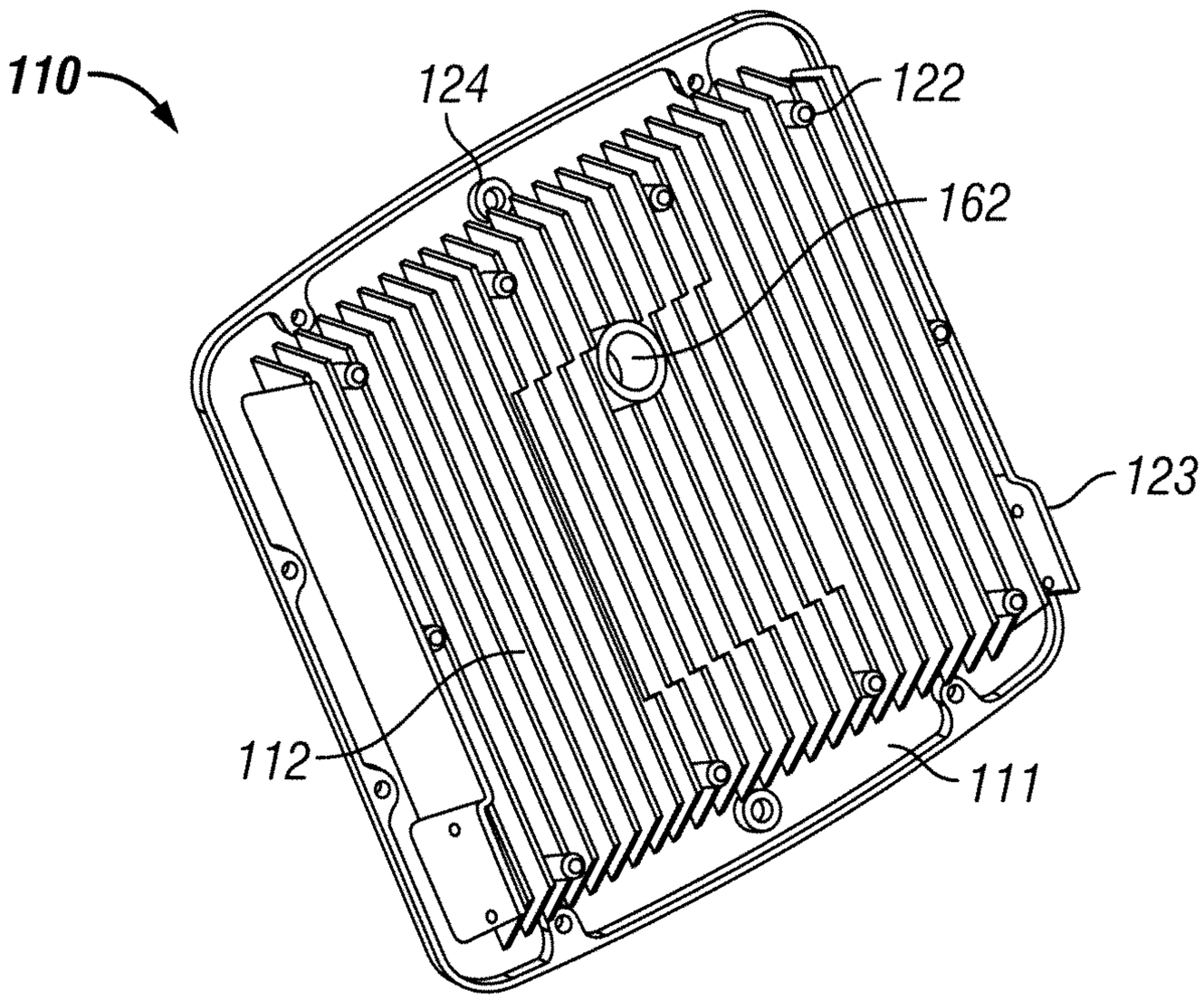

FIG. 2B

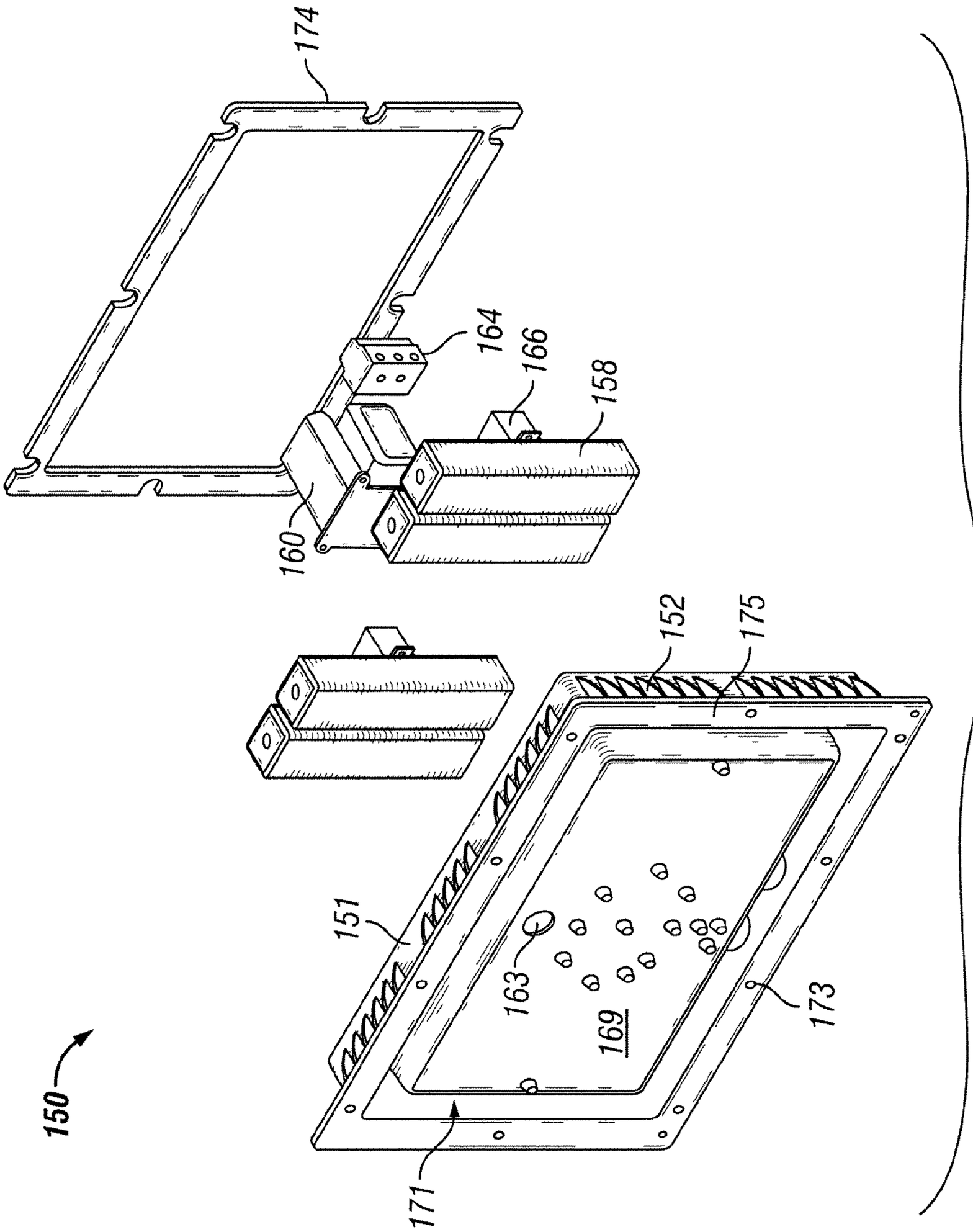
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FIG. 3A

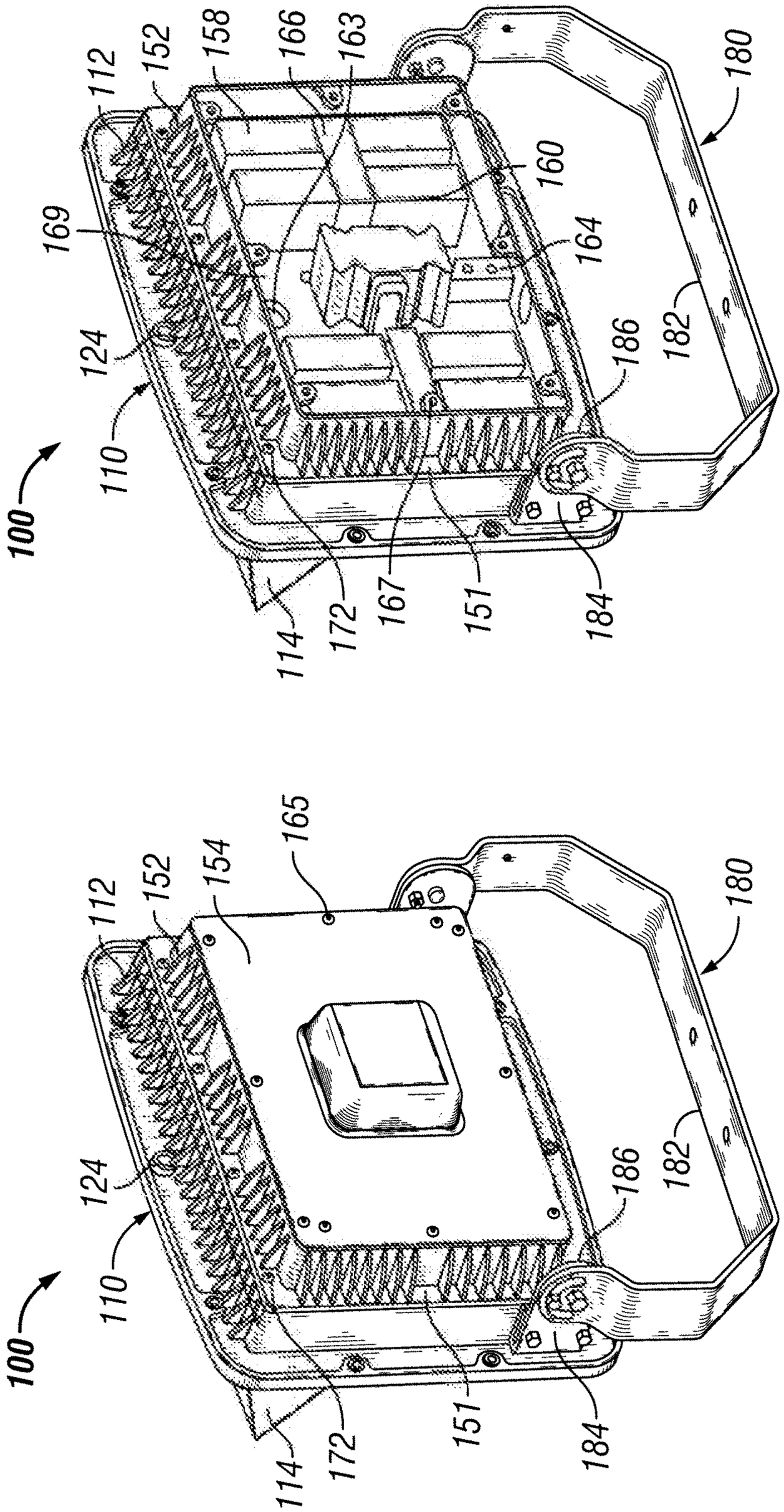
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FIG. 3B

FIG. 3C

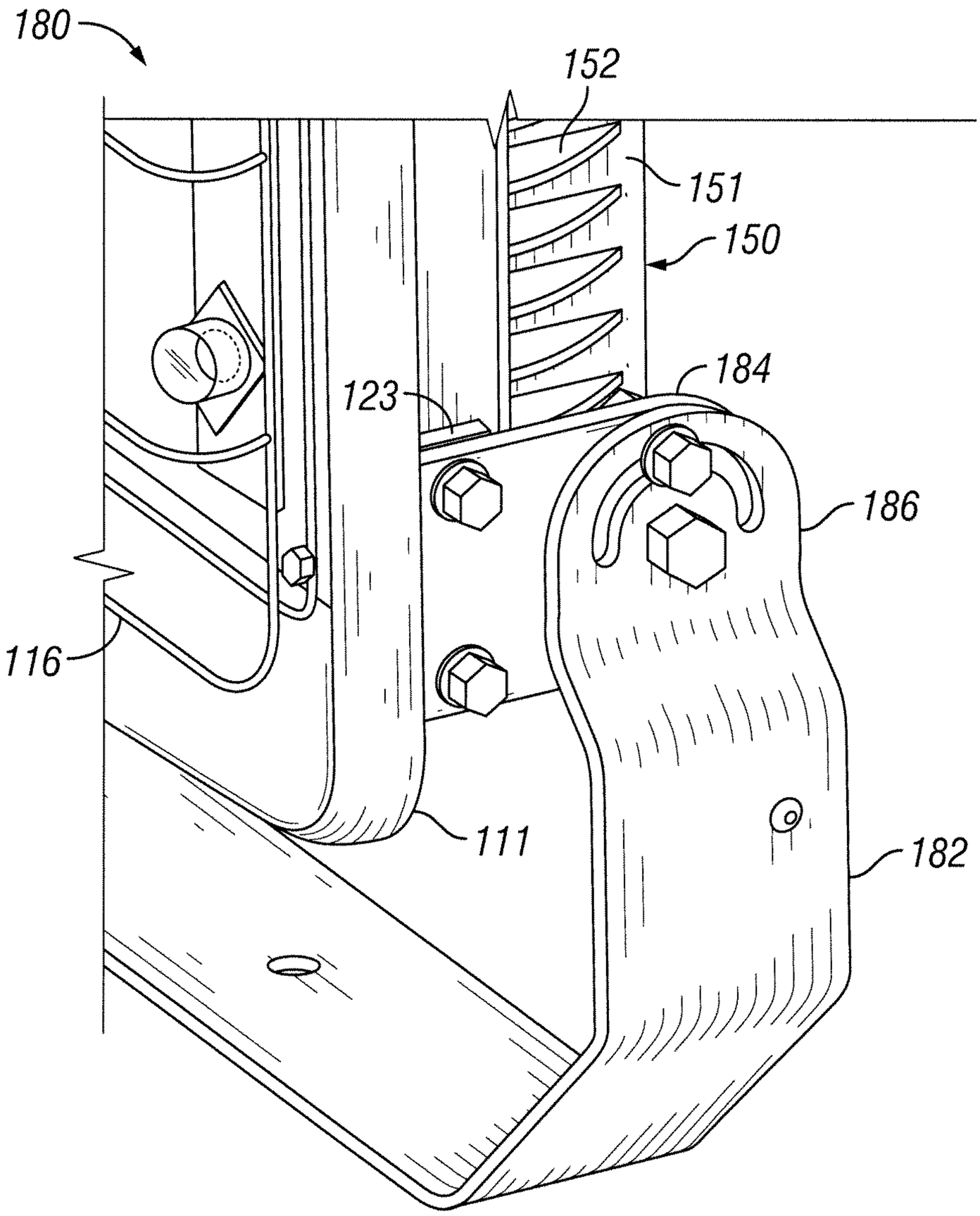

FIG. 4A

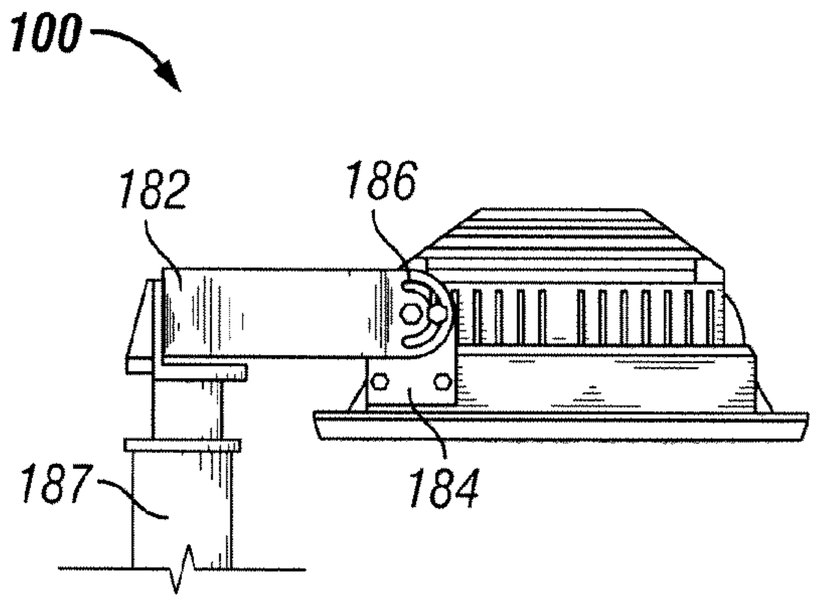

FIG. 4B

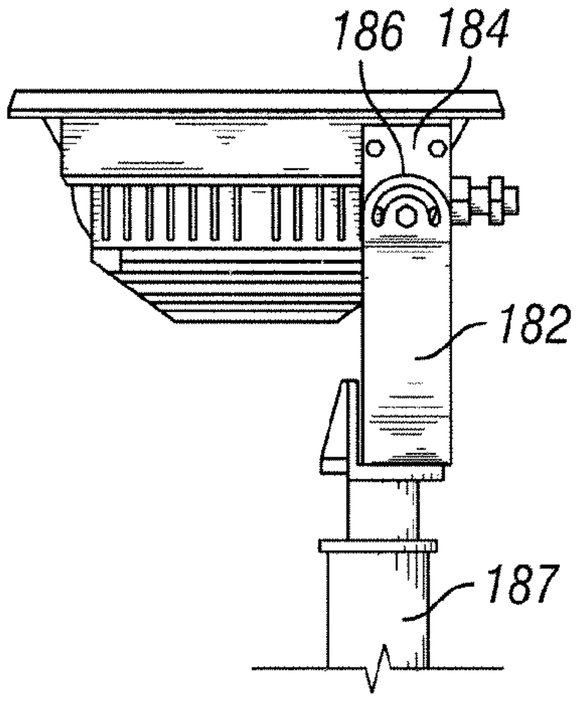

FIG. 4C

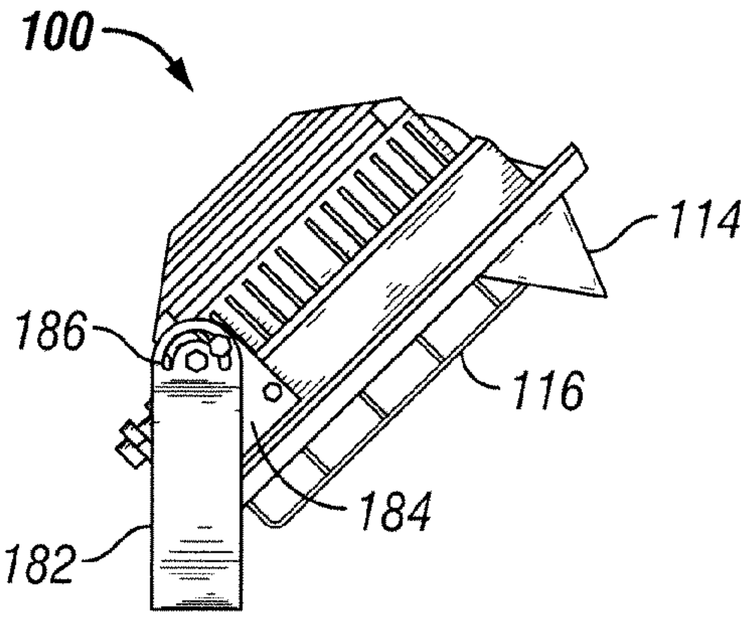

FIG. 4D

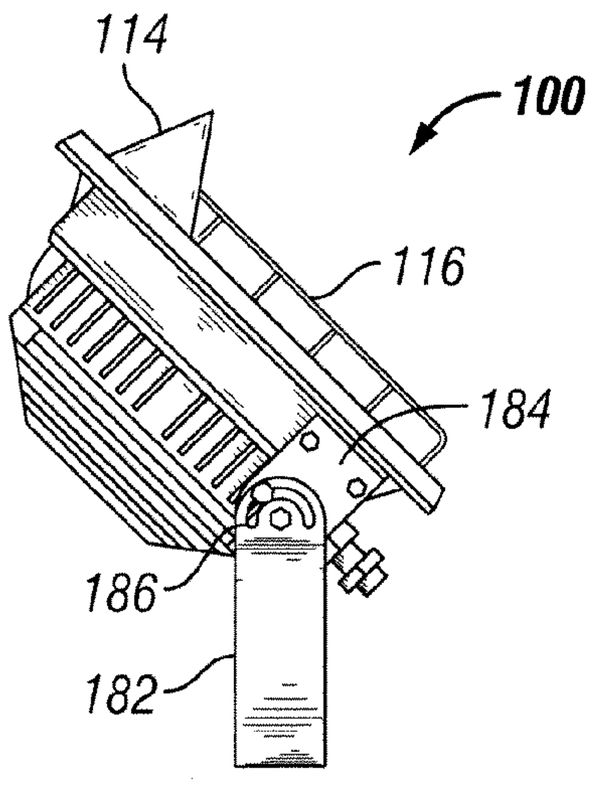

FIG. 4E

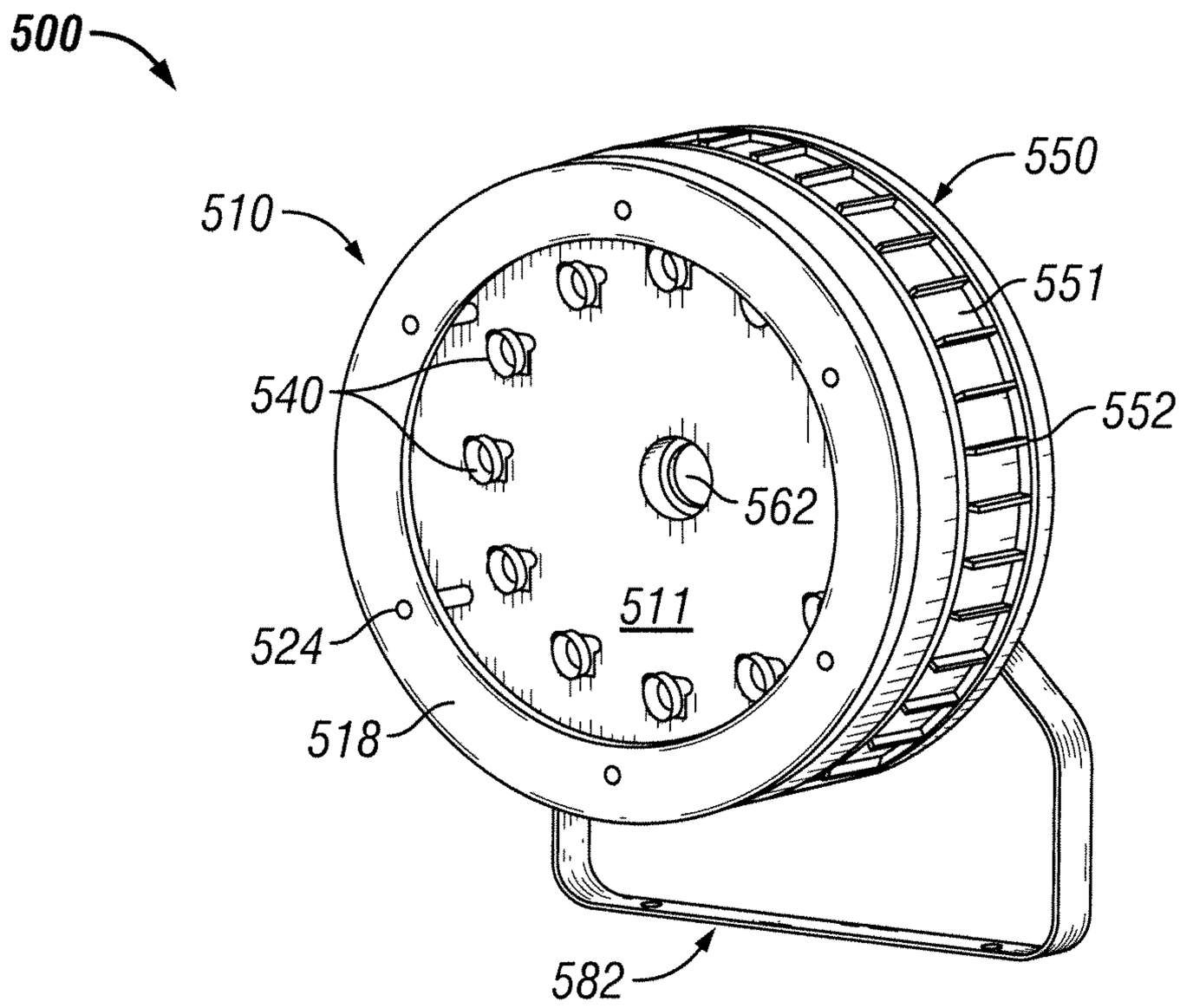
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FIG. 5A

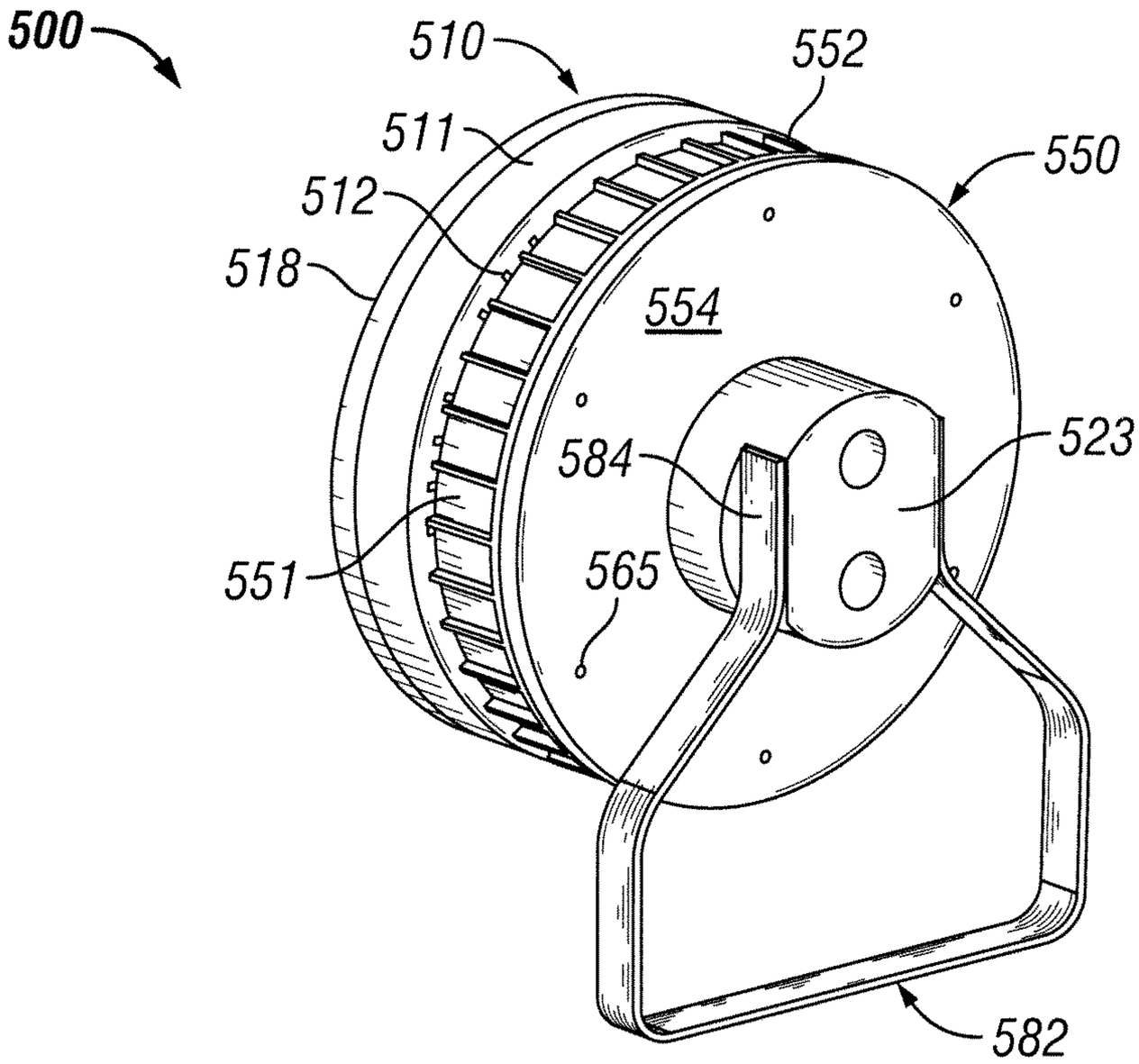
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FIG. 5B

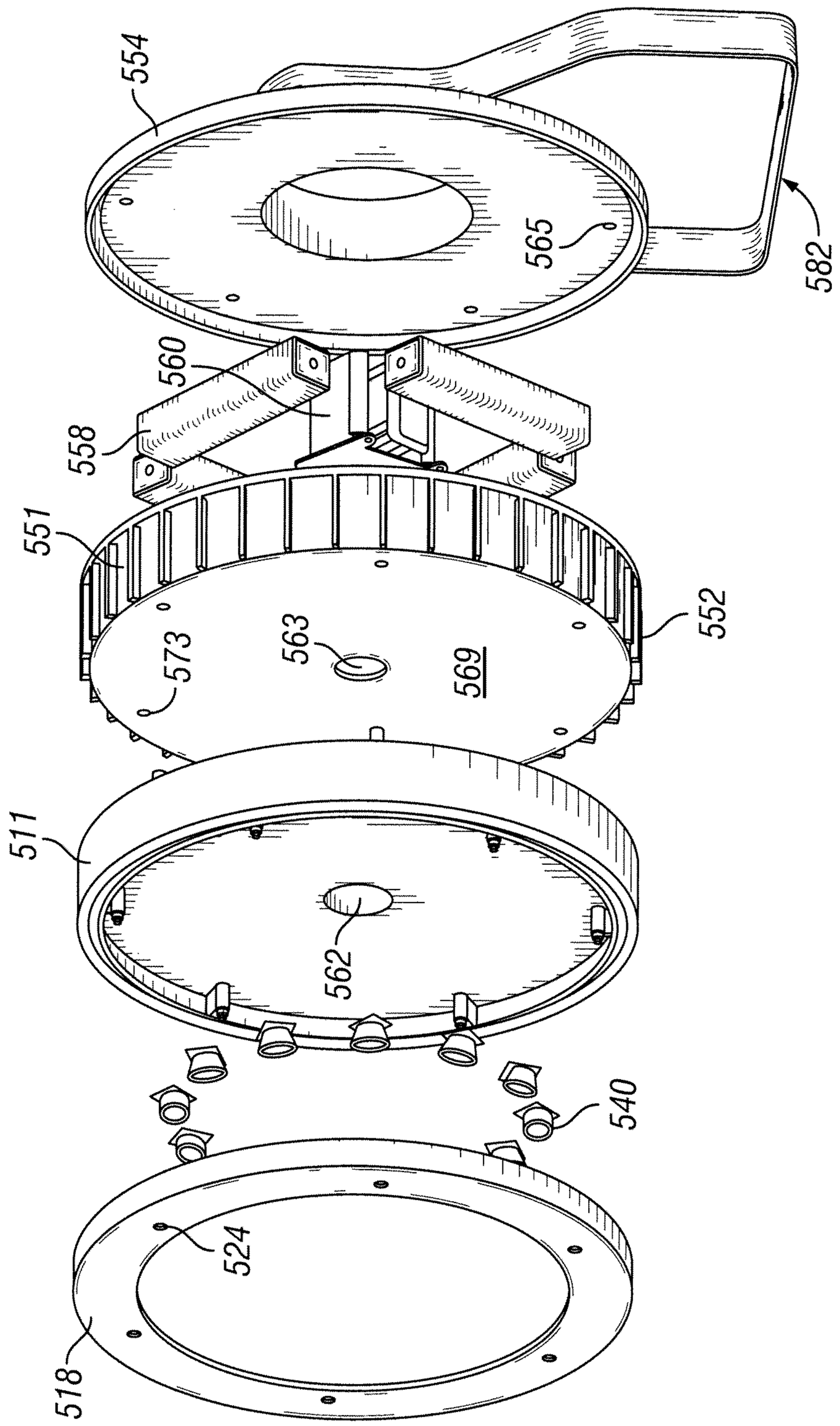

FIG. 5C

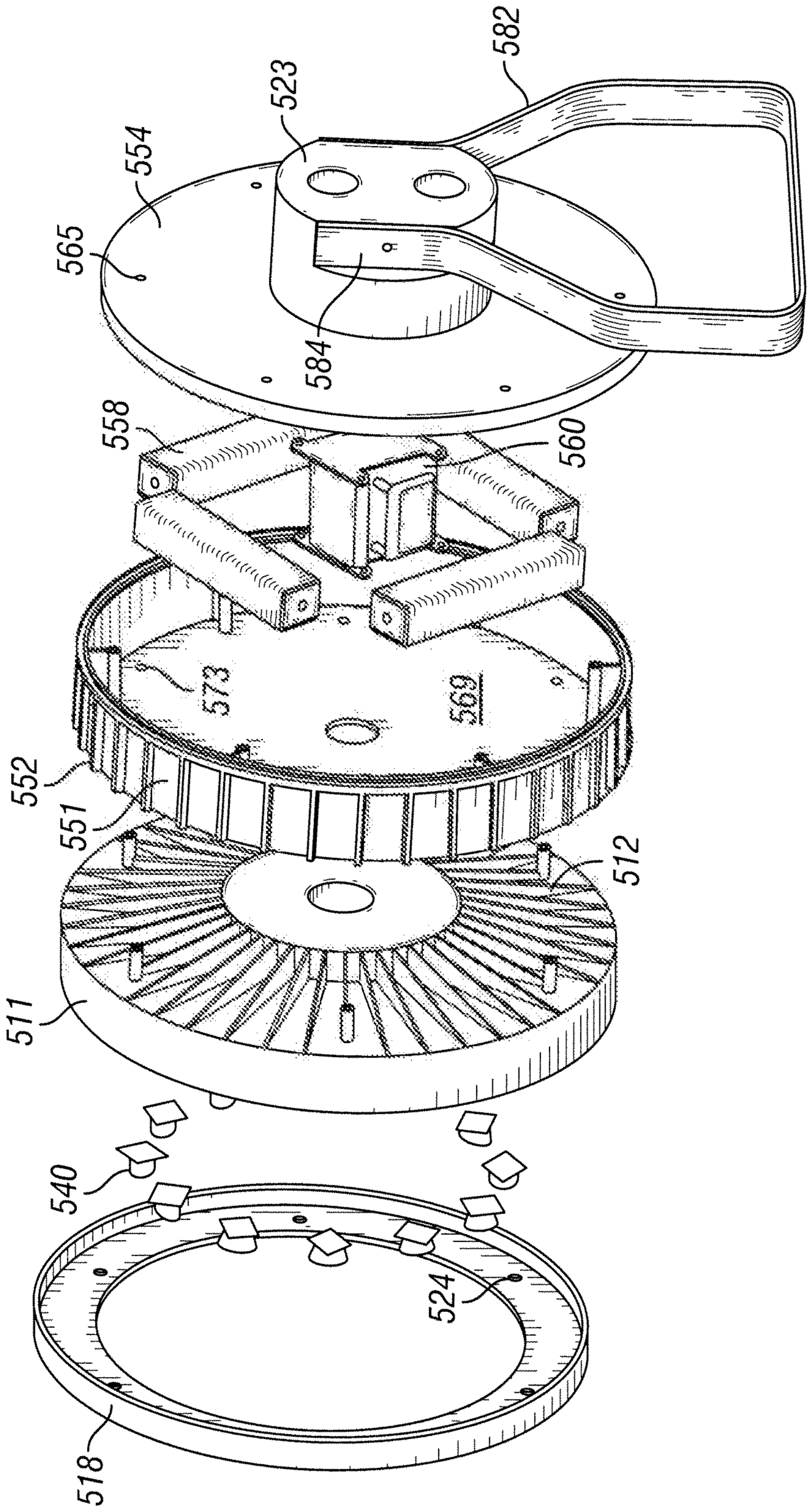

FIG. 5D

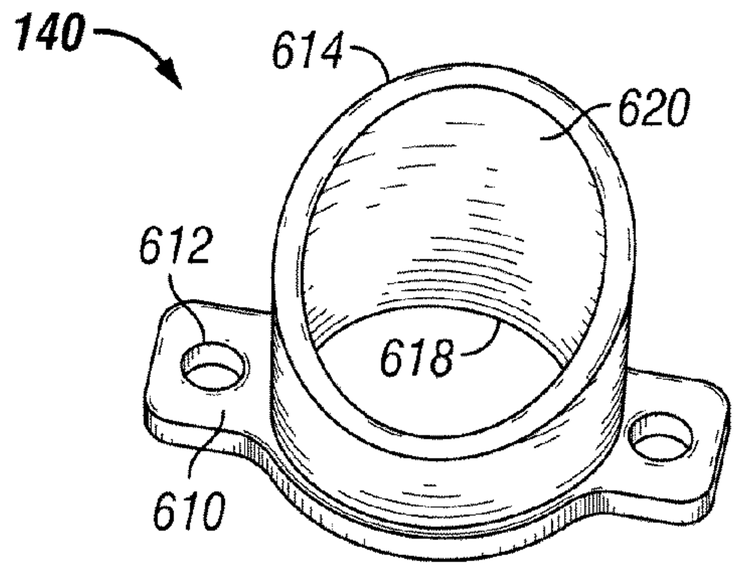

FIG. 6A

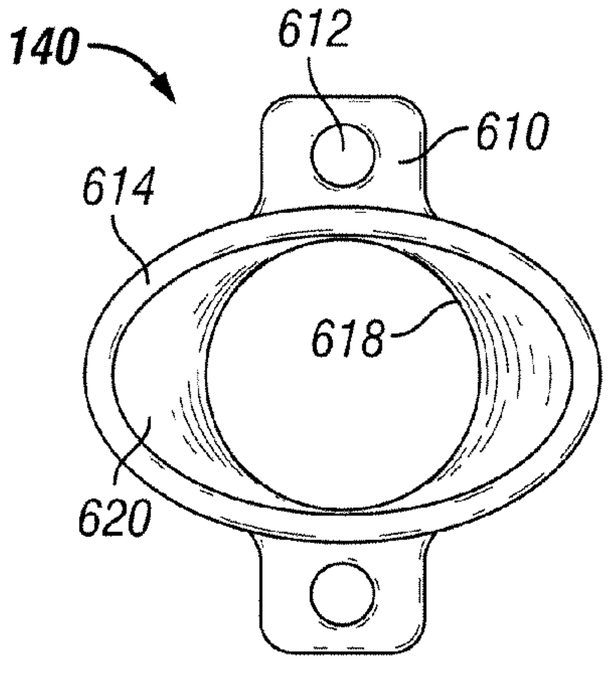

FIG. 6B

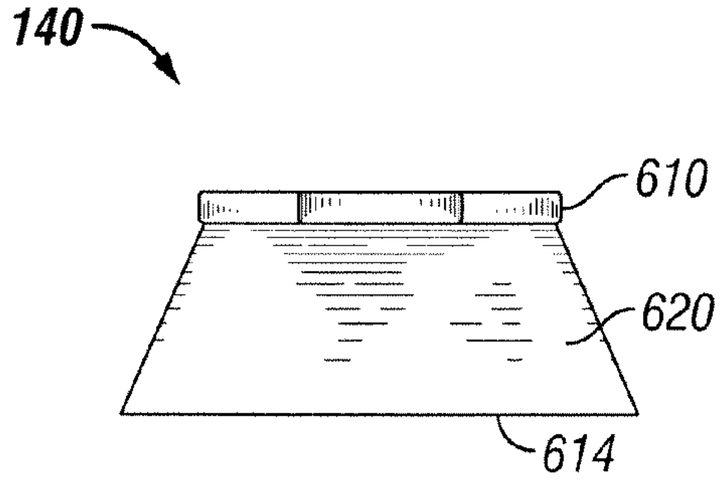

FIG. 6C

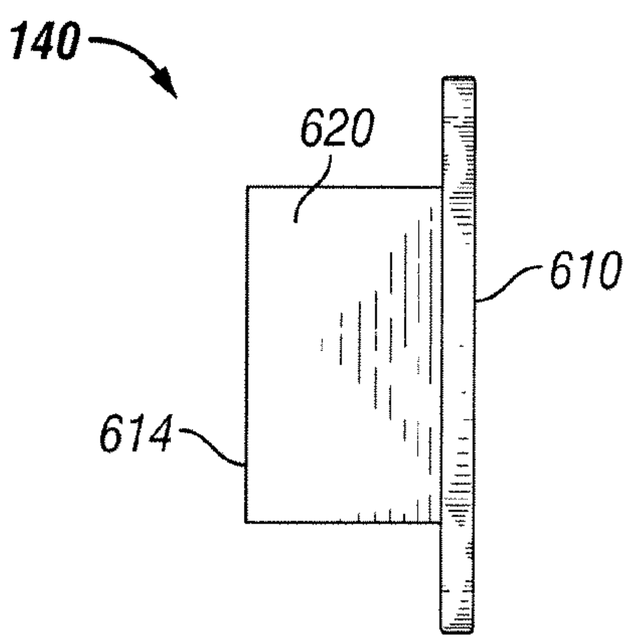

FIG. 6D

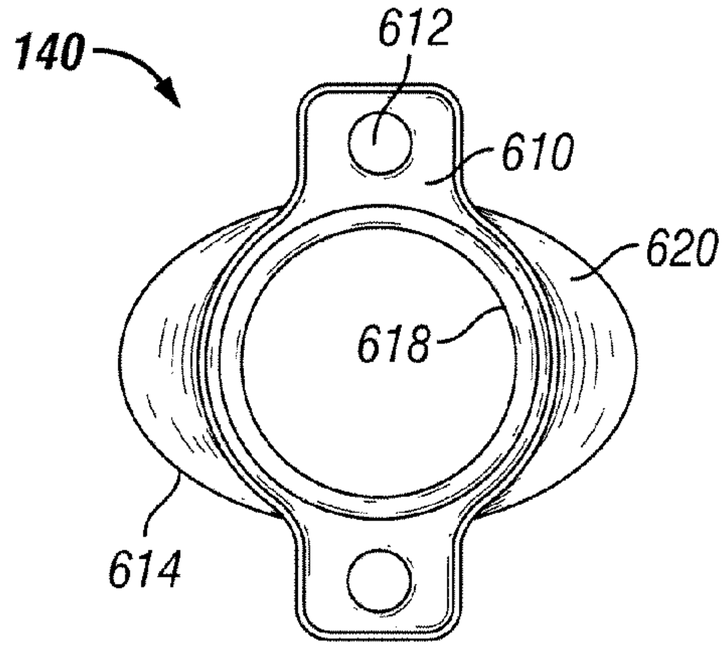

FIG. 6E

LIGHT-EMITTING DIODE (LED) FLOODLIGHT

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority from U.S. Provisional Patent Application Ser. No. 61/470,554, titled "Light-Emitting Diode (LED) Floodlight" and filed on Apr. 1, 2011, in the names of Patrick Stephen Blincoe, Kantesh Vittal Agnihotri, and Gregg Lehman, the entire contents of which are hereby incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates generally to floodlights and more particularly to systems, methods, and devices for a light emitting diode (LED) floodlight and a reflector.

BACKGROUND

Floodlights are used in many different applications. Such floodlights may be used, for example, in commercial applications and residential applications. Floodlights may also be used in industrial applications and other harsh environments, including but not limited to military applications, onboard ships, assembly plants, power plants, oil refineries, and petrochemical plants. When a floodlight is used in such harsh environments, the floodlight must comply with one or more standards and/or regulations to ensure safe and reliable operation. With the development of lighting technologies (e.g., light emitting diode (LED)) that offer alternatives to incandescent lamps, floodlights using such lighting technologies are becoming more common.

SUMMARY

In general, in one aspect, the disclosure relates to a light emitting diode (LED) floodlight. The LED floodlight can include a LED housing assembly having a number of LEDs mounted on a first front side of a LED housing and a number of heat sink protrusions extending from a back side of the LED housing. The LED floodlight can also include a driver assembly having a driver and a driver housing having a second front side, where the second front side is coupled to the heat sink protrusions extending from the back side of the LED housing, and where the driver controls the LEDs in the LED housing. The LED floodlight can further include a number of air gaps positioned between the second front side of the driver housing, the back side of the LED housing, and the heat sink protrusions.

In another aspect, the disclosure can generally relate to a reflector for a light source of a lighting device. The reflector can include a reflector body having a top portion and a bottom portion, where the bottom portion includes a first aperture that receives the light source and forms a first shape having a first perimeter, where the top portion includes a second aperture that receives light generated by the light source and forms a second shape having a second perimeter. The reflector can also include a fastener receiver, positioned on the reflector body, for receiving a fastener to couple the reflector to the lighting device, where the second perimeter is greater than the first perimeter, and where the second shape is an elongated version of the first shape.

These and other aspects, objects, features, and embodiments will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings illustrate only exemplary embodiments and are therefore not to be considered limiting of its scope, as the exemplary embodiments may admit to other equally effective embodiments. The elements and features shown in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the exemplary embodiments. Additionally, certain dimensions or positionings may be exaggerated to help visually convey such principles. In the drawings, reference numerals designate like or corresponding, but not necessarily identical, elements.

FIGS. **1**A through **1**C show various views of a rectangular LED floodlight in which one or more exemplary embodiments may be implemented.

FIGS. **2**A and **2**B show various views of a LED housing assembly of a rectangular LED floodlight in accordance with one or more exemplary embodiments.

FIGS. **3**A through **3**C show various views of a driver housing assembly of a rectangular LED floodlight in accordance with one or more exemplary embodiments.

FIGS. **4**A through **4**E show various views of a mounting assembly for a LED floodlight in accordance with one or more exemplary embodiments.

FIGS. **5**A through **5**D show various views of a circular LED floodlight in accordance with one or more exemplary embodiments.

FIGS. **6**A through **6**E show various views of an exemplary reflector according to one or more exemplary embodiments.

DETAILED DESCRIPTION

Exemplary embodiments will now be described in detail with reference to the accompanying figures. Like, but not necessarily identical, elements in the various figures are denoted by like reference numerals for consistency. In the following detailed description of the exemplary embodiments, numerous specific details are set forth in order to provide a more thorough understanding of the invention. However, it will be apparent to one of ordinary skill in the art that the invention may be practiced without these specific details. In other instances, well-known features have not been described in detail to avoid unnecessarily complicating the description.

Further, certain descriptions (e.g., top, bottom, side, end, interior, inside) are merely intended to help clarify aspects of the invention and are not meant to limit embodiments of the invention.

In general, embodiments of the invention provide systems, methods, and devices for floodlights. Specifically, embodiments of the invention provide for LED floodlights and reflectors that may be used with a floodlight. LED floodlights described herein may meet or exceed one or more of a number of standards and/or regulations that floodlights may be required to pass in order to be used for certain applications.

While the reflectors discussed herein are with reference to LED floodlights, other types of light fixtures (e.g., spotlights, nightlights, emergency egress lights) may be used in conjunction with embodiments of the reflectors. Further, when multiple reflectors described herein are used for a single light fixture, each reflector may be the same (in terms of, for example, dimensions, shape, material, and/or color) or different when compared to the other reflectors in the light fixture.

A user may be any person that interacts with a LED floodlight and/or a reflector. Examples of a user may include, but are not limited to, an engineer, an electrician, an instrumen-

tation and controls technician, a mechanic, an operator, a consultant, a contractor, and a manufacturer's representative.

In one or more exemplary embodiments, a LED floodlight is subject to meeting certain standards and/or requirements. The International Electrotechnical Commission (IEC) publishes ratings and requirements for LED floodlights. For example, the IEC publishes IP (which stands for Ingress Protection or, alternatively, International Protection) Codes that classify and rate the degree of protection provided against intrusion of solid objects, dust, and water in mechanical casings and electrical enclosures. One such IP Code is IP66, which means that a LED floodlight having such a rating is dust tight and protects against powerful water jets (in this case, 100 liters of water per minute under a pressure of 100 kN/m^2 at a distance of 3 meters) for a duration of at least 3 minutes.

The IEC also publishes temperature ratings for electrical equipment. For example, if a device is classified as having a T4 temperature rating, then the surface temperature of the device will not exceed 135° C. Other entities (e.g., the National Electrical Manufacturers Association (NEMA), the National Electric Code (NEC), Underwriters' Laboratories, Inc. (UL)) may also publish standards and/or requirements for LED floodlights.

Exemplary embodiments of LED floodlights may meet one or more of a number of standards set by one or more of a number of authorities. Examples of such authohrities include, but are not limited to, the National Electric Code (NEC), the Canadian Electric Code (CEC), the IEC, the NEMA, Underwriter's Laboratories (UL), the Standards Council of Canada, Conformité Européenne (CE), and the Appareils destinés à être utilisés en Atmosphères Explosives (ATEX). Examples of such standards include, but are not limited to, Class I, division 2, groups A, B, C, and/or D; Class I, Zone 2; Class II, groups E, F, and/or G; Class III simultaneous presence; Marine and/or Wet locations; Type 4X; IP66; and Ex nA Zone 2. FIGS. **1**A through **1**C show various views of a rectangular LED floodlight **100** in which one or more exemplary embodiments may be implemented. In one or more embodiments, one or more of the components shown in FIGS. **1**A through **1**C may be omitted, repeated, and/or substituted. Accordingly, embodiments of a LED floodlight should not be considered limited to the specific arrangements of components shown in FIGS. **1**A through **1**C.

FIG. **1**A depicts a front perspective view of the LED floodlight **100** in rectangular form, while FIG. **1**B depicts a rear perspective view of the LED floodlight **100**. The LED flood light **100** has a LED housing assembly **110**, a driver housing assembly **150**, and a mounting assembly **180**. The LED housing assembly **110** includes a LED housing **111**, a visor **114**, a guard **116**, a bezel **118**, a number of reflectors **140**, and a number of heat sink protrusions **112** that extend outward from the back surface of the LED housing **111**. The driver assembly **150** includes a driver housing **151** and its own set of heat sink protrusions **152**. The mounting assembly **180** includes a mounting bracket **182**, a hinge plate **184**, and a yoke bracket **186**.

In certain exemplary embodiments, the LED housing **111** of the LED housing assembly **110** receives one or more of a number of components (e.g., LEDs, visor **114**, reflectors **140**) used to create light for the LED floodlight **100**. The LED housing **111** may receive the one or more components in one or more of a number of ways, including but not limited to apertures (for fastening devices), slots, and clamps.

The LED housing **111** may be a single cast member or an assembly of two or more members. The LED housing **111** may be made of any suitable material, including metal (e.g., alloy, stainless steel), plastic, some other material, or any combination thereof. The LED housing **111** may be of any dimensions (e.g., thickness, width, height) suitable for the environment in which the LED floodlight **100** operates. For example, the thickness of the walls of the LED housing **111** may be a minimum amount required to meet the applicable standards. As another example, the front face of the rectangular LED housing **111** may be approximately 21 inches wide by approximately 16 inches high. The LED housing assembly **110** and its components are explained in more detail below with respect to FIGS. **2**A and **2**B.

Optionally, in certain exemplary embodiments, the visor **114** may be coupled to a portion of the LED housing assembly **110**, specifically the front side of the LED housing **111**. The visor **114** may be used to direct light in a certain direction and/or to prevent light from being directed in a certain direction. For example, when the LED floodlight **100** is operating, the visor **114** may be coupled to the top portion of the front side of the LED housing **111** to be compliant with dark sky regulations and concerns. The visor **114** may be made of one or more of any number of suitable materials, including but not limited to aluminum, plastic, an alloy, and stainless steel. The visor **114** may have any dimensions and/or shapes (e.g., length, width, angled portions, angle of angled portions, height). The visor **114** may be translucent, semi-translucent, or non-translucent. The visor **114** may be fixedly or detachably coupled to the LED housing **111**. The visor **114** may be coupled to the LED housing **111** using one or more of a number of methods, including but not limited to epoxy, welding, snap fittings, and fastening devices (e.g., nut and bolt). The visor **114** may also be coupled to the bezel **118** and/or any other component of the LED housing assembly **110**.

Optionally, in certain embodiments, the guard **116** may be coupled to a portion of the LED housing assembly **110**, specifically the front side of the LED housing **111**. The guard **116** may be used to protect one or more components (e.g., the optional lens, the reflectors **140**, the LEDs) positioned on the front side of the LED housing assembly **110**. The guard **116** may also be used in certain applications and/or to meet certain standards. For example, when the LED floodlight **100** is operating in a hazardous location, the guard **116** may be coupled to the front side of the LED housing **111** to be compliant with one or more applicable standards. The guard **116** may be made of one or more of any number of suitable materials, including but not limited to aluminum, plastic, an alloy, and stainless steel. The guard **116** may have any dimensions and/or shapes (e.g., width, height, thickness of bars, spacing between bars in one or more directions, orientation of the bars). The guard **116** may be fixedly or detachably coupled to the LED housing **111**. The guard **116** may be coupled to the LED housing **111** using one or more of a number of methods, including but not limited to welding, snap fittings, and fastening devices (e.g., nut and bolt). The guard **116** may also be coupled to the bezel **118** and/or any other component of the LED housing assembly **110**.

In one or more embodiments, the driver housing **151** of the driver housing assembly **150** receives one or more of a number of components (e.g., drivers, driver brackets, transformer) used to create power and control for the LED floodlight **100**. The driver housing **151** may receive the one or more components in one or more of a number of ways, including but not limited to apertures (for fastening devices), slots, and clamps.

The driver housing **151** may be a single cast member or an assembly of two or more members. The driver housing **151** may be made of any suitable material, including metal (e.g., alloy, stainless steel), plastic, some other material, or any combination thereof. The driver housing **151** may be made of

the same or a different material as the LED housing **111**. The driver housing **151** may be of any dimensions (e.g., thickness, width, height) suitable for the environment in which the LED floodlight **100** operates. For example, the thickness of the walls of the driver housing **151** may be a minimum amount required to meet the applicable standards. The driver housing assembly **150** and its components are explained in more detail below with respect to FIGS. **3**A through **3**C.

In certain exemplary embodiments, the mounting assembly **180** provides for mounting the LED floodlight **100** and/or adjusting the direction of the light generated by the LED floodlight **100**. The mounting assembly **180** may be made of any suitable material, including metal (e.g., alloy, stainless steel), plastic, some other material, or any combination thereof. The mounting assembly **180** may be made of the same or a different material as the LED housing **111** and/or the driver housing **151**. The mounting assembly **180** and its components are explained in more detail below with respect to FIGS. **4**A through **4**E.

In one or more exemplary embodiments, the LED housing assembly **110** and the driver assembly **150** are separated by one or more air gaps. The air gaps may be used to maintain the temperature of the LED housing assembly **110** and/or the driver assembly **150** below a threshold temperature. The threshold temperature may represent an operating temperature at which the LED floodlight **100** and/or one or more components of the LED floodlight **100** may fail. The air gap between the LED housing assembly **110** and the driver assembly **150** may be created by one or more LED housing heat sink protrusions **112**. For example, as shown in FIG. **1**C, each LED housing heat sink protrusion **112** may extend from the back side of the LED housing **111** and abut against a front side (a mating side) of the driver housing **151**.

The LED floodlight **100** shown in FIGS. **1**A through **1**C may be able to withstand one or more of a number of harsh environmental conditions. For example, the LED floodlight **100** may be able to withstand a minimum amount of vibration for a minimum amount of time while operating. As another example, the LED floodlight **100** may be able to withstand exposure to a minimum amount of water for a minimum amount of time.

In certain exemplary embodiments, the LED floodlight **100** is made of one or more cast components. In such a case, one or more of the cast components are finished with a grey epoxy powder coat paint. The grey epoxy powder coat paint may provide protection against fade and ware. The grey epoxy powder coat paint may be applied to the cast components in any thickness (e.g., 1 mill, 5 mils).

The shape of the front of the LED housing assembly **110** and the mating surface of the driver assembly **150**, as shown in FIGS. **1**A through **1**C, are rectangular. However, other shapes (e.g., square, elliptical) may be used for the front of the LED housing assembly **110** and/or the mating surface of the driver assembly **150**. For example, as shown in FIGS. **5**A through **5**D, the shape of the front of the LED housing assembly **110** and the shape of the front side of the driver assembly **150** may be circular. The shape of the front of the LED housing assembly **110** may be the same or different than the shape of the front side of the driver assembly **150**.

FIGS. **2**A and **2**B show various views of the LED housing assembly **100** of the rectangular LED floodlight **100** in accordance with one or more exemplary embodiments. In one or more embodiments, one or more of the components shown in FIGS. **2**A and **2**B may be omitted, repeated, and/or substituted. Accordingly, embodiments of a LED housing assembly should not be considered limited to the specific arrangements of components shown in FIGS. **2**A and **2**B.

The LED housing assembly **110** includes a LED housing **111** that has a front side (shown in FIG. **2**A) and a back side (shown in FIG. **2**B). A wiring aperture **162** traverses the LED housing **111** and receives one or more wires and/or one or more cables that are electrically coupled to the LEDs **142** on the front side of the LED housing **111** and to the drivers located in the driver housing, as described below with respect to FIGS. **3**A through **3**C.

As shown in FIG. **2**A, the front side of the LED housing **111** is coupled to one or more of a number of components. For example, a bezel **118** is coupled to the outer perimeter of the front side of the LED housing **111**. The bezel **118** may be of any thickness and/or width (i.e., distance from the outer edge toward the center of the bezel **118**). The bezel **118** may be used for aesthetic and/or protective purposes. The bezel **118** may include one or more components, including but not limited to a gasket (not shown) positioned between the back side of the bezel **118** and the front side of the LED housing **111**. The bezel **118** may also, or in the alternative, be used to secure a lens (not shown).

The bezel **118** may be coupled to the front side of the LED housing **111** using one or more of a number of methods or manners, including but not limited to bolting, welding, using epoxy, brazing, press fitting, mechanically connecting, using a flat joint, and using a serrated joint. For example, as shown in FIG. **2**A, one or more fastening apertures **124** may be included in the bezel **118** and the LED housing **111** so that, when the bezel **118** is positioned in a certain way with respect the LED housing **111**, the fastening apertures **124** align. In such a case, one or more of a number of fastening devices (e.g., screws, bolts) may traverse the fastening apertures **124** to couple the bezel **118** to the front side of the LED housing **111**. Some or all of the surface (e.g., where the bezel **118** and/or gasket couples to the front side of the LED housing **111**) of the front side of the LED housing **111** may be free of paint to provide a better seal and assure compliance with one or more of a number of standards, including but not limited to IP66.

Referring to FIG. **2**A, the front side of the LED housing **111** also includes a number of LEDs **142** with a corresponding number of reflectors **140**. The LEDs **142** may be an array of LEDs or a single LED. The LEDs **142** may one or more of any type of LED, including but not limited to chip-on-board and discrete. A thermal pad (not shown) and/or any other similar thermal device may be positioned between the LEDs **142** and the front side of the LED housing **111**. The reflectors **140** may be positioned over the LEDs **142**. The reflectors **140**, LEDs **142**, and/or any other components (e.g., thermal pads) associated with the LEDs may be coupled to the front side of the LED housing **111** using one or more of a number methods, including but not limited to epoxy, fastening devices (e.g., screws), and welding/soldering. One or more portions of the front side of the LED housing **111** may be raised, as shown in FIG. **2**A, for example, to receive and/or dissipate heat generated by the LEDs **142**, reflectors **140**, and/or other components associated with the LEDs.

FIG. **2**B shows the back side of the LED housing assembly **110**. A number of heat sink protrusions **112** protrude from the back side of the LED housing **111**. In certain exemplary embodiments, the heat sink protrusions **112** provide an air gap between the LED housing assembly **110** and the driver assembly **150** to maintain the temperature of the LED housing assembly **110** and the driver assembly **150** (and/or one or more of their components) below a threshold temperature. The heat sink protrusions **112** of the driver housing **111** may have varying shapes (e.g., thickness, height, curvature) and/or varying spacing along the back side of the LED housing **111**.

For example, the heat sink protrusions **112** may be fins (e.g., blades). As another example, the heat sink protrusions **112** may be one or more undulations (e.g., a number of sine waves in series). The heat sink protrusions **112** may extend from the back side of the LED housing **111** perpendicularly or at some non-normal angle. Each heat sink protrusion **112** may extend from the back side of the LED housing **111** at the same or different angles relative to the other heat sink protrusions.

The heat sink protrusions **112** may have any of a number of configurations. As shown in FIG. **2**B, the heat sink protrusions **112** may be linear. In such a case, the linear heat sink protrusions **112** may have a number of orientations along the back side of the LED housing **111**. For example, the heat sink protrusions **112** may be parallel to each other and run vertically along at least a portion of the height of the back side of the LED housing **111**. The heat sink protrusions **112** may also be parallel to each other and run horizontally along at least a portion of the width of the back side of the LED housing **111**. The heat sink protrusions **112** may also be parallel to each other and run diagonally, at any of a number of angles, along at least a portion of the width of the back side of the LED housing **111**.

The heat sink protrusions **112** may also run quasi-parallel to each other. In a quasi-parallel configuration, a portion of the heat sink protrusions **112** may be parallel to each other, while the remainder of the heat sink protrusions **112** are not parallel to the portion. For example, half of the heat sink protrusions **112** may be positioned vertically along the back side of the LED housing **111**, while the other half of the heat sink protrusions **112** may be positioned horizontally along the back side of the LED housing **111**. Those skilled in the art will appreciate that a number of other quasi-parallel configurations of the heat sink protrusions **112** along the back side of the LED housing **111** may be attained.

The heat sink protrusions **112** may also be non-linear and/or oriented antiparallel to each other. For example, the heat sink protrusions **112** may be sine waves that run parallel to each other in some orientation (e.g., vertical, horizontal) along the back side of the LED housing **111**. As another example, the heat sink protrusions **112** may be concentric circles, positioned along the back side of the LED housing **111**, that are centered at the center of the LED housing **111**. Those skilled in the art will appreciate that a number of other non-linear and antiparallel configurations of the heat sink protrusions **112** along the back side of the LED housing **111** may be attained.

In certain exemplary embodiments, the back side of the LED housing **111** (specifically, the far end of the heat sink protrusions **112**) includes one or more fastener receivers **122**. The fastener receivers **122** receive fastener devices (not shown) to couple the LED housing assembly **110** to the driver assembly **150**. The fastener receivers **122** may be configured in any manner appropriate to receive the corresponding fastener devices. For example, as shown in FIG. **2**B, the fastener receiver **122** may be a threaded aperture that traverses some or all of the LED housing **111** from the back side of the LED housing **111** and receives a screw. As another example, the fastener receiver **122** may be a slot, integrated with the end of one or more of the heat sinks **112**, that receives a clip or a clamp.

The LED housing **111** may also include one or more mounting assembly receivers **123**. In the case shown in FIG. **2**B, a mounting assembly receiver **123** is positioned on each side toward the bottom of the LED housing **111**. The mount assembly receiver **123** may be configured in any manner appropriate to receive and couple to the mounting assembly. For example, as shown in FIGS. **1**B and **2**B, the mounting assembly receivers **123** may include one or more apertures for receiving fastening devices (e.g., bolts) to couple the mounting assembly to the LED housing **111**. Another example of a mounting assembly receiver **123** is shown below with respect to FIGS. **5**A through **5**D.

FIGS. **3**A through **3**C show various views of a driver assembly **150** of a rectangular LED floodlight **100** in accordance with one or more exemplary embodiments. In one or more embodiments, one or more of the components shown in FIGS. **3**A through **3**C may be omitted, repeated, and/or substituted. Accordingly, embodiments of a driver assembly should not be considered limited to the specific arrangements of components shown in FIGS. **3**A through **3**C.

The driver assembly **150** includes a driver housing **151** that has a front side (shown in FIG. **3**A) and a back side (shown in FIG. **3**B). The front side of the driver housing **151** may be larger (e.g., wider, higher) than the back side of the driver housing. A wiring aperture **163**, corresponding to the wiring aperture **162** of the LED housing assembly, traverses the driver housing **151** and receives one or more wires and/or one or more cables that are electrically coupled to the LEDs **142** on the front side of the LED housing **111** (described above with respect to FIGS. **2**A and **2**B) and to the drivers located in the driver housing **151**.

In certain exemplary embodiments, the driver housing **151** may include one or more heat sink protrusions **152** positioned around the perimeter of the driver housing **151**. Unlike the heat sink protrusions **112** of the LED housing **111**, the heat sink protrusions **152** of the driver housing **151** may not extend from the back side of the driver housing **151**. The heat sink protrusions **152** of the driver housing **151** may have one or more of a number of dimensions (e.g., thickness, height) and one or more of a number of shapes (e.g., linear, curved, rectangular, crossed, straight). The spacing of the heat sink protrusions **152** may be constant and/or varying along the perimeter of the driver housing **151**. The heat sink protrusions **152** may extend perpendicularly (i.e., normally) from the driver housing **151**, as shown in FIG. **3**B. The heat sink protrusions **152** may also, or in the alternative, extend from the driver housing **151** at a non-normal angle.

The front side of the driver housing **151** includes a mating surface **175** that couples to the end of the heat sink protrusions **112** extending from the back side of the LED housing **111**. The mating surface **175** of the front side of the driver housing **151** may extend from the outer edge of the driver housing **151** to some distance (including completely) toward the center of the front side of the driver housing **151**. In other words, a cavity may or may not be formed at the front side of the driver housing **151** by the mating surface **175**.

In certain exemplary embodiments, the mating surface **175** includes one or more fastener receivers **173**. The fastener receivers **173** may be aligned with corresponding fastener receivers **122** positioned on the back side of the LED housing **111**. The fastener receivers **173** receive fastener devices (not shown) to couple the driver assembly **150** to the LED housing assembly **110**. The fastener receivers **173** may be configured in any manner appropriate to receive the corresponding fastener devices. For example, as shown in FIG. **2**B, the fastener receiver **173** may be a threaded aperture that traverses the driver housing **151** and receives a screw. As another example, the fastener receiver **173** may be a slot that receives a detachable clip or a clamp. The fastener receiver **173** may also include an integrated fastening device, such as a clip or clamp that is integrated with (e.g., fixedly coupled to) the driver housing **151**.

If the mating surface **175** of the front side of the driver housing **151** only extends a partial way toward the middle of

the driver housing **151**, than a cavity results. The cavity **171** shown in FIG. **3**A may be of any size (e.g., depth, width, height) for proper ventilation and/or cooling of components within the driver housing **151**. The back side of the cavity **171** includes a back plate **169** onto which one or more of the components of the driver assembly **150** are mounted. The components may be mounted on the front side (facing the LED housing **111**) of the back plate **169** and/or the back side of the back plate **169**. The components may be mounted to the back plate **169** using one or more of a number of methods, including but not limited to epoxy, fastening devices (e.g., screws that are received by apertures in the back plate **169**), and welding/soldering.

The back side of the driver housing **151** has a back cover **154** that is removably coupled to the driver housing **151**. A gasket **174** may be positioned between the driver housing **151** and the back cover **154** to ensure proper sealing between the driver housing **151** and the back cover **154**. A proper seal between the driver housing **151** and the back cover **154** may be needed to meet one or more standards, including but not limited to IP66. The back cover **154** may be cast and/or may be made of any suitable material, including but not limited to stainless steel, an alloy, plastic, and aluminum.

The back cover **154** may include one or more fastener receivers (shown in FIG. **3**B as being occupied by fastening devices **165**). The fastener receivers of the back cover **154** may align with corresponding fastener receivers **167** on the back side of the driver housing **151** when the back cover **154** is positioned in a certain manner with respect to the driver housing **151**. The fastener receivers of the back cover **154** may receive fastener devices **165** to couple the back cover **154** to the driver housing **151**. The fastener receivers may be configured in any manner appropriate to receive the corresponding fastener devices **165**. For example, as shown in FIG. **3**B, the fastener receiver may be a threaded aperture that traverses all or part of the driver housing **151** and receives a fastening device **165** that is a screw. The same screw may be received by a corresponding aperture **167** in the back side of the driver housing **151** to couple the back cover **154** to the driver housing **151**. Alternatively, or in addition, one or more other fastening methods may be used to couple the back cover **154** to the driver housing **151**.

When the back cover **154** is removed (detached) from the back side of the driver housing **151**, as shown in FIG. **3**C, one or more components mounted on the back side of the back plate **169** may be accessed. Accessing the components may allow a user to perform one or more of a number of actions, including but not limited to cleaning the components, maintaining the components, repairing the components, reconfiguring the components, and replacing the components. In certain exemplary embodiments, the back plate **169** and/or the back side of the driver housing **151** are not painted where the back plate **169** couples to the driver housing **151**.

FIGS. **3**A and **3**C show some components that may be mounted on the back side of the back plate **169** in certain exemplary embodiments. Specifically, FIG. **3**C shows a perspective back view of the LED floodlight **100** with the back cover **154** removed. For example, one or more drivers **158**, one or more transformers **160**, and/or one or more terminal blocks **164** may be coupled to the back side of the back plate **169**. The one or more drivers **158** may be mounted to the back side of the back plate **169** using one or more driver brackets **166**. A driver bracket **166** may be made of one or more of a number of materials, including but not limited to sheet metal. The drivers **158**, driver brackets **166**, transformers **160**, and/or terminal blocks **164** may be coupled to the back side of the back plate **169** using one or more of a number of fastening methods, including but not limited to snapping features, epoxy, welding/soldering, and fastening devices (e.g., screws that are received by apertures in the back side of the back plate **169**). Those skilled in the art will appreciate that one or more other components may be coupled to the back side of the back plate **169**.

The number and/or orientation of the pairs of reflectors **140** and LEDs **142** on the front side of the LED housing **111** may vary based on one or more of a number of factors, including but not limited to the shape of the LED floodlight, the size of the front side of the LED floodlight, the application for which the LED floodlight is used, and the wattage of the LEDs **142**. For example, for the rectangular LED floodlight **100** shown in FIGS. **1**A and **2**A, the pairs of reflectors **140** and LEDs **142** are arranged in a matrix of three rows and four columns, where each row and column, together or independently, is evenly spaced apart. In such a case, as shown in FIGS. **1**C, **3**A, and **3**C, there may be four drivers **158**, two positioned on either side of the transformer **160**, coupled to the back side of the back plate **169** of the driver housing **150**.

Other quantities and/or orientations of the pairs of reflectors **140** and LEDs **142** may be used for the rectangular LED floodlight **100**. For example, the pairs of reflectors **140** and LEDs **142** may be arranged in a matrix of two rows and four columns, where each row and column, together or independently, is evenly spaced apart. In such a case, there may be three drivers **158** (one driver **158** positioned on one side of the transformer **160** and two on the other side of the transformer **160**) coupled to the back side of the back plate **169** of the driver housing **150**. As another example, the pairs of reflectors **140** and LEDs **142** may be arranged in a matrix of three rows and two columns, where each row and column, together or independently, is evenly spaced apart. In such a case, there may be two drivers **158** (one driver **158** positioned on one side of the transformer **160** and one on the other side of the transformer **160**, or both drivers **158** positioned on one side of the transformer **160**) coupled to the back side of the back plate **169** of the driver housing **150**. As yet another example, the pairs of reflectors **140** and LEDs **142** may be arranged in a matrix of two rows and two columns, where each row and column, together or independently, is evenly spaced apart. In such a case, there may be two drivers **158** (one driver **158** positioned on one side of the transformer **160** and one on the other side of the transformer **160**, or both drivers **158** positioned on one side of the transformer **160**) coupled to the back side of the back plate **169** of the driver housing **150**.

FIGS. **4**A through **4**E show various views of a mounting assembly **180** for a LED floodlight **100** in accordance with one or more exemplary embodiments. In one or more embodiments, one or more of the components shown in FIGS. **4**A through **4**E may be omitted, repeated, and/or substituted. Accordingly, embodiments of a mounting assembly should not be considered limited to the specific arrangements of components shown in FIGS. **4**A through **4**E. For example, the mounting assembly **180** may include or be used with a SFA6 slipfitter adapter (not shown).

FIG. **4**A shows an exemplary mounting assembly **180** and includes a mounting bracket **182**, a hinge plate **184**, and a yoke bracket **186**. In certain exemplary embodiments, the hinge plate **184** couples to the LED housing assembly **110** and/or the driver assembly **150**. For example, as shown in FIG. **4**A, the hinge plate **184** is coupled to the mounting assembly receiver **123** positioned toward the bottom of the LED housing **111**. The hinge plate **184** may be coupled to the LED housing assembly **110** and/or the driver assembly **150** on one or more of a number of ways, including but not limited to epoxy, welding/soldering, and fastening devices.

The hinge plate, yoke bracket **186**, and/or mounting bracket **182** may be made of one or more of a number of materials, including but not limited to aluminum, an alloy, plastic, and stainless steel. The characteristics (e.g., dimensions, shape, material) of the components (e.g., mounting bracket **182**, hinge plate **184**, yoke bracket **186**) of the mounting assembly **180** may be such that the mounting assembly **180** safely and reliably couples to the remainder of the LED floodlight **100** in any suitable environment and/or for any duration of time during the operation of the LED floodlight **100**.

The yoke bracket **186** may include one or more features (e.g., slots) that allow a user to rotate, tilt, swivel, or otherwise move the light generated by the LED floodlight in a particular vertical direction and/or angled position. For example, the yoke bracket **186** in FIGS. **4**A-**4**E allow the light generated by the LED floodlight to be directed at any point within a 180° arc. There may be more than one yoke bracket **186** for the mounting assembly **180**. The mounting bracket **182** may be coupled to the yoke bracket **186**. The mounting bracket **182** may be coupled to an external feature (e.g., a pole **187**, a side of a building) to secure the LED floodlight **100** in a fixed or relative position. The mounting bracket **182** may be coupled to one or more features in one or more of a number of ways, including but not limited to fastening devices (e.g., bolts) that traverse apertures in the mounting bracket **182**.

As shown in FIGS. **4**B through **4**E, the mounting assembly **180** is coupled to a pole **187**. FIG. **4**B shows the mounting assembly **180** manipulated in such a way as to direct the light generated by the LED floodlight **100** approximately downward) (0°). FIG. **4**C shows the mounting assembly **180** manipulated in such a way as to direct the light generated by the LED floodlight **100** approximately upward) (180°). FIG. **4**D shows the mounting assembly **180** manipulated in such a way as to direct the light generated by the LED floodlight **100** at approximately a 45° angle. FIG. **4**E shows the mounting assembly **180** manipulated in such a way as to direct the light generated by the LED floodlight **100** at approximately a 135° angle. The mounting assembly **180** allows the LED floodlight **100** to be mounted vertically, horizontally, and/or at any other angle.

FIGS. **5**A through **5**D show various views of a circular LED floodlight **500** in accordance with one or more exemplary embodiments. In one or more embodiments, one or more of the components shown in FIGS. **5**A through **5**D may be omitted, repeated, and/or substituted. Accordingly, embodiments of a circular LED floodlight should not be considered limited to the specific arrangements of components shown in FIGS. **5**A through **5**D. For example, although not shown in FIGS. **5**A through **5**D, the circular LED floodlight **500** may include a visor and/or a guard. Further, those skilled in the art will appreciate that the LED floodlight may have one or more other shapes, including but not limited to square and elliptical.

Aside from the shape and/or configuration, the components and their functionality/properties are substantially the same as the corresponding components described above with respect to the rectangular LED floodlight **100** of FIGS. **1**A through **3**C. Specifically, the LED housing assembly **510** (including one or more of its components such as the LED housing **511**, the bezel **518**, the heat sink protrusions **512**, the fastening apertures **524**, the wiring aperture **562**, the optional visor, the optional guard, the LEDs, and the reflectors **540**), the driver assembly **550** (including one or more of its components such as the driver housing **551**, the heat sink protrusions **552**, the wiring aperture **563**, the driver **558**, and the transformer **560**), and the mounting assembly **580** (including one or more of its components such as the mounting bracket **582** and the hinge plate **584**) are substantially similar to the corresponding components described above with respect to the rectangular LED floodlight **100** of FIGS. **1**A through **4**E.

The dimensions of the components of the circular LED floodlight **500** may vary. For example, the diameter of the front side of the LED housing **511** may be approximately 16.3 inches. Further, the distance from the front side of the LED housing **511** to the back plate **554** of the driver housing **550** may be approximately 6.8 inches. If a mounting assembly receiver **523** is coupled to the back plate **554**, then the distance from the front side of the LED housing **511** to the end of the mounting assembly receiver **523** may be approximately 10.3 inches.

Further, as described above, other quantities and/or orientations of the pairs of reflectors **540** and LEDs, as well as the components (e.g., drivers **558**, transformer **560**) positioned in the driver housing **550**, different from that shown in FIG. **5**A, may be used for the circular LED floodlight **500**. Likewise, various quantities and/or orientations of the pairs of reflectors and LEDs, as well as the components (e.g., drivers, transformer) positioned in the driver housing, may be used for a LED floodlight of any other shape (e.g., square, elliptical).

FIGS. **6**A through **6**E show various views of a reflector **140** in accordance with one or more exemplary embodiments. In one or more embodiments, one or more of the components shown in FIGS. **6**A through **6**E may be omitted, repeated, and/or substituted. Accordingly, embodiments of a reflector should not be considered limited to the specific arrangements of components shown in FIGS. **6**A through **6**E. For example, those skilled in the art will appreciate that the reflector may have one or more other shapes, including but not limited to square.

FIG. **6**A shows a perspective front view of the reflector **140**. The reflector **180** includes a base **610** having a fastener receiver **612**. The base **610** may be shaped as a flange. In certain exemplary embodiments, the base is coupled to the bottom portion **618** of the reflector body **620**. The base **610** may be positioned on one side of the reflector **140**, on opposite sides of the reflector **140** (as shown in FIG. **6**A), all around the reflector **140**, or some other portions of the reflector **140**. The bottom of the base **610** may be flush with the bottom portion **618** of the reflector body **620**. Alternatively, the bottom of the base **610** may be higher or lower than the bottom portion **618** of the reflector body **620**. The fastener receiver **612** may also be located separately from the base and positioned elsewhere on the reflector body **620**.

In one or more exemplary embodiments, the base **610** and the reflector body **620** may be a continuous piece (e.g., unibody construction, cast construction). Alternatively, the base **610** may be a separate piece that is coupled to the reflector body **620**. In such a case, the base **610** may be coupled to the reflector body **620** in one or more of a number of ways, including but not limited to welding, threaded coupling, snap fittings, and fastening devices. The base **610** and the reflector body **620** may be made of the same or different materials. The base **610** and reflector body **620** may be made of any one or more of a number of materials, including but not limited to aluminum, stainless steel, glass, and an alloy.

The one or more fastener receivers **612** of the base **610** may be used to couple the reflector **140** to the front side of the LED housing. The fastener receivers **612** may be configured in any suitable manner to couple the reflector **140** to the front side of the LED housing. For example, if the fastener is a screw, then the fastener receiver **612** is an aperture that traverses the base **612** and receives the screw to couple the reflector **140** to the front side of the LED housing. As another example, if the

fastener is a clamp, than the fastener receiver **612** may be a slot in the base **610** that allows the clamp to couple the reflector **140** to the front side of the LED housing. In certain exemplary embodiments, the base **610** and the fastener receiver **612** are the same component.

In one or more exemplary embodiments, the reflector body **620** is shaped in such a way that the shape of the top portion **614** of the reflector body **620** is an elongated version of the bottom portion **618** of the reflector body **620**. The elongated version of the top portion **614** relative to the bottom portion **618** may be in one dimension (e.g., along the x-axis), two dimensions (e.g., along the x-axis and the y-axis), or three dimensions (as when the plane of the bottom portion **618** is antiparallel with the plane of the top portion **614**). For example, as shown in FIGS. **6**B and **6**E, the top portion **614** of the reflector body **620** is shaped as an ellipse, while the bottom portion **618** of the reflector body **620** is shaped as a circle. The height of the ellipse formed by the top portion **614** in FIGS. **6**B and **6**E is approximately the same as the diameter of the circle formed by the bottom portion **618**. For example, the circle formed by the bottom portion **618** may be approximately 16.8 mm, while the ellipse formed by the top portion **614** may be approximately 28 mm along the x-axis and 17.25 mm along the y-axis. In such a case, the elongation substantially occurs in one dimension.

The sides of the reflector body **620** may be linear and/or curved between the bottom portion **618** and the top portion **614**. The sides of the reflector body **620** shown in FIGS. **6**A through **6**E are linear throughout. The sides of the reflector body **620** may be treated to meet one or more of a number of performance parameters. Examples of such performance parameters may include, but are not limited to, reflectance level, heat transfer, and corrosion resistance. For example, the inside of the reflector body **620** may be vacuum metallized to have a mirror like finish to cause the reflectance level to exceed 92%. In such a case, the coating on the inside of the reflector body **620** may be between 0.05 μm and 0.2 μm.

The walls of the reflector body **620** may have a thickness that is uniform and/or variable along the length of the reflector body **620**. For example, as shown in FIGS. **6**A through **6**E, the walls of the reflector body **620** are approximately 1.75 mm uniformly through the reflector body **620**. Likewise, the thickness of the base **610** may be uniform and/or variable throughout the base **610**. For example, as shown in FIGS. **6**A through **6**E, the thickness of the base **610** is approximately 2.32 mm throughout the base **610**.

In certain exemplary embodiments, the aperture formed by the bottom portion **614** of the reflector body **620** is disposed on one plane, while the aperture formed by the top portion **618** of the reflector body **620** is disposed on another plane. The aforementioned planes may be parallel to each other. In such a case, the height of the reflector **140**, looking from a side view, is constant throughout. For example, the height of the reflector **140** shown in FIG. **6**C may be approximately 13 mm. Alternatively, the aforementioned planes may be antiparallel, in which case the height of the reflector **140**, from a side view, would vary along the reflector **140**.

Using exemplary embodiments of reflectors described herein, the lighting efficiency increases. For example, for a NEMA 7X6 light fixture with 12 LEDs paired with 12 reflectors, the efficiency (including material absorption losses) is approximately 89%. In this case, each LED is rated for 1200 lumens (14,400 lumens in total) with a maximum illuminance of 0.75 Lux (over 65 meters) and a maximum illuminance of 3.3 Lux. For this example, the area illuminated was 120 m by 120 m. Further, the field angle was 95°×75° (50% brightness) and the beam angle was 120°×120° (10% brightness).

Embodiments of the present invention also provide for LED floodlights of various shapes and sizes where heat sink protrusions are strategically placed between the LED housing and the driver assembly to allow for improved air flow to improve the reliability and availability of the LED floodlight by keeping the temperature of the LED floodlight below a threshold temperature. Exemplary embodiments described herein also allow for ease in maintaining, cleaning, and/or replacing one or more components of the driver assembly by having a removable back plate to allow access inside the driver housing. Exemplary embodiments of the LED floodlights described herein are designed to meet one or more of a number of standards and/or regulations to be used in a variety of conditions.

Although the inventions are described with reference to preferred embodiments, it should be appreciated by those skilled in the art that various modifications are well within the scope of the invention. From the foregoing, it will be appreciated that embodiments of the LED floodlight and the reflector overcome the limitations of the prior art. Those skilled in the art will appreciate that the LED floodlight and the reflector are not limited to any specifically discussed application and that the embodiments described herein are illustrative and not restrictive. From the description of the exemplary embodiments, equivalents of the elements shown therein will suggest themselves to those skilled in the art, and ways of constructing other embodiments of the LED floodlight and the reflector will suggest themselves to practitioners of the art. Therefore, the scope of the LED floodlight and the reflector is not limited herein.

What is claimed is:

1. A light emitting diode (LED) floodlight, comprising:

a LED housing assembly comprising:

a plurality of LEDs mounted on a first front side of a LED housing; and

a first plurality of heat sink protrusions extending from a back side of the LED housing;

a driver assembly comprising a driver and a driver housing having a second front side, wherein the second front side is coupled to the first plurality of heat sink protrusions extending from the back side of the LED housing, and wherein the driver controls the plurality of LEDs in the LED housing; and

a plurality of air gaps positioned between the second front side of the driver housing, the back side of the LED housing, and the first plurality of heat sink protrusions.

2. The LED floodlight of claim **1**, wherein the LED housing further comprises a plurality of reflectors comprising a bottom portion in a first plane and a top portion in a second plane, wherein the plurality of LEDs are positioned within the plurality of reflectors at the bottom portion, and wherein a first shape of the top portion is an elongated version of a second shape of the bottom portion.

3. The LED floodlight of claim **2**, wherein the first shape of the top portion is an ellipse, and where in the second shape of the bottom portion is a circle.

4. The LED floodlight of claim **3**, wherein the second shape is elongated in one dimension relative to the first shape.

5. The LED floodlight of claim **3**, wherein the first plane and the second plane are parallel.

6. The LED floodlight of claim **2**, wherein each of the plurality of reflectors comprises an identical reflector shape as a remainder of the plurality of reflectors.

7. The LED floodlight of claim **1**, wherein the front side of the LED housing has a substantially similar shape as the back side of the LED housing.

8. The LED floodlight of claim 7, wherein the back side of the LED housing and the second front side of the driver housing comprise the substantially similar shape.

9. The LED floodlight of claim 8, wherein the back side of the LED housing and the second front side of the driver housing are circular.

10. The LED floodlight of claim 8, wherein the back side of the LED housing and the second front side of the driver housing are rectangular.

11. The LED floodlight of claim 1, further comprising a visor coupled to the front side of the LED housing.

12. The LED floodlight of claim 1, wherein the driver housing further comprises a second plurality of heat sink protrusions.

13. The LED floodlight of claim 1, wherein the driver housing further comprises a removable back cover.

14. The LED floodlight of claim 13, wherein the driver is accessible when the removable back cover is removed.

15. The LED floodlight of claim 1, further comprising a mounting bracket coupled to the driver housing, wherein the mounting bracket is coupled to the driver housing a hinge plate.

16. The LED floodlight of claim 14, wherein the driver is accessible when the driver housing remains coupled to the LED housing.

17. The LED floodlight of claim 12, wherein the second plurality of heat sink fins are disposed on at least one side of the driver housing.

18. The LED floodlight of claim 1, further comprising a mounting bracket coupled to the LED housing, wherein the mounting bracket is coupled to the LED housing a hinge plate.

19. The LED floodlight of claim 18, wherein the driver housing further comprises a removable back cover that can be removed when the mounting bracket is coupled to the LED housing.

20. The LED floodlight of claim 18, wherein the driver housing and the LED housing can have an adjustable position using the mounting bracket.

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